MAM 65 - 1

Comparison of Rank Correlations Concerning Salary, Size of Staff and Degree Level

1 OCTOBER 1965

Management Analysis Memorandum ...

Office for Laboratory Management

Office of the Director of Defense
Research and Engineering
Washington, D.C.

COMPARISON OF RANK CORRELATIONS CONCERNING SALARY, SIZE OF STAFF AND DEGREE LEVEL

Frank A. Nicolai*

1 October 1965

Management Analysis Memorandum 65-1

of the

Office for Laboratory Management
Office of the Director of Defense Research and Engineering
Washington, D. C. 20301

Approved for publication:

Assistant Director (Laboratory Management)
Office of the Deputy Director (Research and Technology)

*Executive Trainee, Office of the Secretary of Defense, assigned to the Office of the Deputy Director of Defense Research and Engineering (Research and Technology).

As shown in Tables I, II and III, this analysis covers three distinct population groups: (1) 7 Navy laboratories, all of which are under Bureau of Ships control, (2) 23 private companies for which data were collected by Mr. E. M. Glass, and (3) 14 private companies which were part of a survey by the Stanford Research Institute (SRI). The criterion for choosing these groups was sameness of data-gathering methods.

While the seven Navy laboratories represent only a small fraction of the total in the Department of Defense (DoD), they constitute the only organizational DoD entity for which sufficient data were available at the time of the study.

A. Influence of the size of a professional staff on the proportion of professionals receiving high salaries:

The coefficient of rank (r) correlation for the Navy laboratories is approximately -0.4 (r_{a1} = -0.393), whereas the same coefficient for the other two populations is insignificant (r_{a2} = +0.022 and r_{a3} = -0.068). The different sizes of the surveyed populations may account for some of this difference, but it appears that there is at least one meaningful alternate explanation: Since these Navy laboratories are actually part of an organizational entity (the Bureau of Ships), they are administered under similar policies. Thus, regardless of staff size, they are likely to have the same structure with respect to supervisory positions. For this reason, a negative rank correlation is probable and, in fact, does occur. The other two populations are composed of separate elements (private companies) that may be individually different in regard to organizational structure and administrative policy. The relationship between proportion of high salaries and size of staff, therefore, is random.

B. Influence of the proportions of professionals with high degrees, highly paid professionals with high degrees, and highly paid professionals:

For the seven Navy laboratories there is a significant positive rank correlation between percent of total professionals at \$14,000+ and percent of Ph.D.'s on the professional staff (r_{b1} = +0.750). For the 23 private companies there is no such correlation (r_{b2} = +0.096), and for the 14 companies in the SRI survey there is a slight positive correlation (r_{b3} = +0.415). It is possible that the low coefficients for private companies can be attributed to the low cutoff point in salary. A cutoff at \$16,000 or \$18,000 would probably make this rank-correlation method more discriminative.

Since the objective of these tests is to measure, in terms of salary, how professionals with high degrees are treated relative to other professionals, a better test for comparing the treatment of this group by government and by private industry could be constructed as follows: Using the \$14,000+ cutoff point for the Navy

[1] Acting Assistant Director (Laboratory Management), Office of the Director of Defense Research and Engineering.

laboratories, perform the same ranking tests. Determine the percent of all professionals in these labs who earn $14,000 or more. Then apply that percentage figure to the two populations in private industry to discover what their salary cutoffs should be. Having established the cutoff points, determine rank correlation by means of the same techniques.

A more direct measure of how professionals with high degrees are treated in relation to professionals having lower degrees is obtained for these three populations in terms of the rank-correlation coefficients d and e. Since the number of Ph.D.'s and masters who receive $14,000+ is a subset of the total number of professionals in that salary range, the six rank-correlation coefficients for columns 1 and 5 and columns 1 and 6 (Tables I, II and III) in all three populations give a good measure of how the high-degree professionals are treated in each environment.

As may be seen from the three rank-correlation coefficients, the private companies tend to pay Ph.D. professionals higher salaries than the Navy laboratories:

$$r_{d_1} = +0.321 \text{ (Navy laboratories)}$$

$$r_{d_2} = +0.708 \text{ (23 companies)}$$

$$r_{d_3} = +0.793 \text{ (14 companies)}$$

When we add to the Ph.D. group the professionals with master's degrees, the discrepancy, while still large, is diminished:

$$r_{e_1} = +0.786 \text{ (Navy laboratories)}$$

$$r_{e_2} = +0.831 \text{ (23 companies)}$$

$$r_{e_3} = +0.899 \text{ (14 companies)}$$

Thus it appears that, in the private companies, people with high degrees are better compensated in relation to those with low degrees than their counterparts in the Navy laboratories.

Table I. Navy's Bureau of Ships—7 Laboratories

Laboratory	(1) % Total prof. at $14,000+ by rank	(2) Total population, by rank: Size	(3) Total population, by rank: % Ph.D.'s	(4) Total population, by rank: % Ph.D.'s & Masters	(5) At $14,000+, by rank: % Ph.D.'s	(6) At $14,000+, by rank: % Ph.D.'s & Masters
David W. Taylor Model Basin	2	2	3	5	2	1
Naval Radiological Defense Lab.	1	6	1	1	6	4
Navy Mine Defense Lab.	3	7	5	7	1	2
Navy Electronics Lab.	5	1	2	2	5	5
Navy Marine Engineering Lab.	4	5	4	6	4	3
Naval Applied Science Lab.	7	3	7	3	7	7
Navy Underwater Sound Lab.	6	4	6	4	3	6

Spearman's coefficients of rank correlation:

Columns 1 and 2 = -0.393
Columns 1 and 3 = +0.750
Columns 1 and 4 = -0.036
Columns 1 and 5 = +0.321
Columns 1 and 6 = +0.786
Columns 6 and 4 = -0.571
Columns 5 and 3 = -0.071

Total population of 7 Navy laboratories : 2995

Maximum size . . . 693
Minimum size . . . 267
Average size . . . 428

Table II. Private Companies—23 (ODDR&E Data)
(Identified by Letters A - W)

Company	(1) % Total prof. at $14,000+ by rank	(2) Total population, by rank: Size	(3) Total population, by rank: % Ph.D.'s	(4) Total population, by rank: % Ph.D.'s & Masters	(5) At $14,000+ by rank: % Ph.D.'s	(6) At $14,000+ by rank: % Ph.D.'s & Masters
O	1	6	23	20	1	2
D	15	1	22	23	1	3
M	5	3	19	22	3	1
H	11	5	15	15	4	12
Q	4	2	13	7	5	11
A	3	21	8	3	6	4
V	8	18	6	5	7	8
N	13	15	18	19	8	7
S	2	16	1	1	9	5
I	10	19	16	11	10	10
G	7	9	3	6	11	6
F	9	13	14	16	11	15
K	22	8	19	17	13	22
R	6	20	11	10	14	9
J	16	10	7	8	15	14
E	18	7	10	12	16	16
T	13	12	17	17	17	13
P	20	14	12	14	18	18
B	12	11	2	2	19	17
L	17	23	4	4	20	19
U	19	17	5	9	21	20
W	23	4	21	21	22	23
C	21	22	9	13	23	21

Spearman's coefficients of rank correlation:

Columns 1 and 2 = +0.022
Columns 1 and 3 = +0.096
Columns 1 and 4 = +0.276
Columns 1 and 5 = +0.708
Columns 1 and 6 = +0.831
Columns 6 and 4 = -0.015
Columns 5 and 3 = -0.395

Total population of 23 companies: 33,445

Maximum size . . . 5031
Minimum size . . . 132
Average size . . . 1454

Table III. Private Companies—14 (SRI Data)
(Identified by Numbers 1-14)

Company	(1) % Total prof. at $14,000+ by rank	(2) Total population, by rank: Size	(3) Total population, by rank: % Ph.D.'s	(4) Total population, by rank: % Ph.D.'s & Masters	(5) At $14,000+, by rank: % Ph.D.'s	(6) At $14,000+, by rank: % Ph.D.'s & Masters
1	9	1	9	10	9	9
2	5	11	3	3	6	6
3	3	8	12	12	4	3
4	8	3	7	6	5	4
5	1	14	1	1	2	1
6	7	4	5	5	11	11
7	12	9	12	13	13	13
8	2	5	2	2	1	2
9	11	10	10	8	8	8
10	6	7	6	7	3	7
11	4	6	11	11	10	5
12	13	2	8	9	12	12
13	10	13	11	7	7	10
14	14	12	4	4	14	14

Spearman's coefficients of rank correlation:

Columns 1 and 2 = -0.068
Columns 1 and 3 = +0.415
Columns 1 and 4 = +0.387
Columns 1 and 5 = +0.793
Columns 1 and 6 = +0.899

Total population of 14 companies: 29,073

Maximum size 5954
Minimum size 75
Average size 2077